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A Study on Millets and Their Role in Diabetes Management

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Introduction

Diabetes mellitus (DM) is a significant global health issue, particularly in low- and middle-income countries, where its prevalence is rising rapidly. In 2019, diabetes was the tenth leading cause of death worldwide, with an estimated 1.9 million fatalities, and projections suggest that by 2050, around 592 million people could be affected by the disease. The World Health Organization (WHO) attributes this increase to lifestyle factors such as poor diet, physical inactivity, and urbanization, which have led to a rise in non communicable diseases (NCDs)

In India, diabetes has reached epidemic proportions, with over 101 million individuals diagnosed and an additional 15.7% of the population classified as prediabetic.

Recent research emphasizes the potential benefits of incorporating millets into the diets of individuals with diabetes. Millets are nutrient-dense grains that are gluten-free, low on the glycemic index, and high in fiber, making them suitable for blood glucose management. They are also rich in essential vitamins and minerals. The United Nations has recognized 2023 as the International Year of Millets, highlighting their importance in promoting food security and health.

Millets are small-seeded cereal grains belonging to the grass family, cultivated for thousands of years as staple crops. They are highly adaptable to diverse climates, including arid and semi-arid regions, making them valuable for sustainable agriculture. India is the largest producer of millets globally, contributing significantly to their cultivation and consumption. (jail, march 2012)

millets are rich in fiber, proteins, vitamins, and minerals, offering health benefits such as improved digestion and reduced risk of chronic diseases like diabetes.

addition to staple food crops, such as wheat and rice, which people have been eating for years, millet remains highly nutritious and beneficial, but it is an underutilized crop that has a multitude of benefits for health; the most beneficial are low glycemic index (GI), high fiber content, polyunsaturated fatty acids (PUFA), non-acid-forming potential, and being gluten-free (7). Millets are nutrients rich in vitamins, minerals, proteins, essential fatty acids, energy, carbohydrates, plant chemicals, and non-glycemic polysaccharides .Millet grains show huge benefits in their resistance to drought and high-yield production in areas with less water availability.

Millets are not just good for health but the planet as well.millet are considered a smart food because they are environmentally sustainable with a lower cardon footprint. They have multiple uses from food and fodder to brewing and biofuels.

Type of millets

Finger Millet (Ragi)

Finger millet is a powerhouse of calcium and polyphenols. It is beneficial for diabetes due to its ability to improve insulin sensitivity and slow down glucose absorption, keeping blood sugar levels in check.

- **Barnyard Millet**

Barnyard millet has the lowest carbohydrate content among millets, making it particularly beneficial for managing diabetes. Its

- high fiber content helps in reducing cholesterol and controlling post-meal blood sugar spikes.

- **Kodo Millet**

Kodo millet is rich in antioxidants and fiber, which are effective in managing diabetes. It also helps in reducing inflammation and supporting weight management, essential for diabetic individuals.

- **Little Millet**

Little millet is easy to digest and is packed with essential nutrients. Its high fiber content ensures slow digestion and prevents sudden sugar level spikes.

Glycaemic index :

Millet is lower on the glycemic index (GI) than many other grains. That means it raises your blood sugar slowly and gradually instead of in quick spikes. High-fiber, low-GI foods keep blood sugar steady, lower cholesterol, and help you lose weight. All of these things are helpful for people with diabetes.

Here's a chart showing the **Glycemic Index (GI)** and **Glycemic Load (GL** of different types of millets:

Millet Type	Glycemic Index (GI)	Glycemic Load (GL)
Pearl Millet	55	15
Foxtail Millet	58	14
Finger Millet	54	13
Sorghum Millet	55	14
Proso Millet	52	12
Barnyard Millet	48	11
Little Millet	50	12
Kodo Millet	52	12

Aim : A Study on Millets and Their Role in Diabetes Management

Objective:

1. Examine the specific nutrition in various millet.
2. Assess the long term effects of millets based diet on diabetes.
3. To analyse the glycemic index and glycemic loan of different millets .
4. To identify the most effective millets varieties and preperation method for optimal diabetes
5. To study consumer awareness and attitude toward millets consumption as diabetes management.
6. To investigate the potential long term benefits of millets in preventing diabetes.

Review of literature

1. **Monica Yadav et al : September 2024** " criticle review on the efficacy of Kodo, Sorghum, and foxtail millets in the management of type 2 diabetes mellitus"

Type 2 diabetes mellitus (DM), a growing global health concern, is closely linked to poor dietary habits and sedentary lifestyles. Ayurveda identifies this condition as Apathyanimmataja Prameha and recommends millets like Kodo, Sorghum, and foxtail for their antidiabetic properties. These "Nutri Cereals" possess a low glycemic index, are gluten-free, and are rich in vitamins, minerals, flavonoids, and antioxidants, making them beneficial for managing hyperglycemia and lifestyle diseases. The Indian government's 2023 declaration of the International Year of Millets highlights their role in promoting healthier food choices. Integrating Ayurvedic wisdom with modern research supports the use of millets in diabetes management.

2 . **Taylor and Francis et al (november 2024)** "comprehensive review on influence of millet processing on carbohydrate-digesting enzyme inhibitors and implications for diabetes management"

Millets, often undervalued as food sources, are gaining recognition for their bioactive compounds that can help regulate blood sugar levels in diabetics. This review examines different millet varieties and processing methods to extract these beneficial compounds, focusing on their ability to inhibit enzymes like α-amylase and α-glucosidase involved in carbohydrate metabolism. Key components such as phenols, flavonoids, and proteins in millets are highlighted for their roles in reducing glucose absorption. However, the processing of millets can significantly affect the retention of these bioactive compounds. Efficient extraction techniques like Soxhlet and ultrasonic-assisted methods are discussed as ways to enhance the therapeutic potential of millets, positioning them as valuable dietary supplements for diabetes management

3 **.Sonekamble Vijaya et al (november 2023)** "Nutritional & Nutraceutical Potential of Millets - A Mighty Cereal"

Millets, often overlooked compared to larger grains, are gaining recognition for their impressive nutritional benefits. These ancient grains are rich in macronutrients, dietary fiber, vitamins, and minerals, making them essential for a balanced diet. They support weight management, help regulate blood sugar levels, and promote heart health due to their low glycemic index and high antioxidant content. Additionally, millets are gluten-free, making them suitable for those with gluten sensitivities. Their anti-inflammatory and anticancer properties further enhance their appeal as a nutraceutical option. Beyond nutrition, millets contribute to sustainable agriculture by preserving biodiversity and adapting to climate change challenges. Embracing millets can lead to healthier diets and a more sustainable future.

4 . **Fred Kwame Ofosu et al (march 2020)** "Phenolic Profile, Antioxidant, and Antidiabetic Potential Exerted by Millet Grain Varietie"

This study assessed the antioxidant and antidiabetic properties of four millet varieties grown in South Korea. The free fractions were analyzed for total antioxidant capacity using ABTS and DPPH assays, along with inhibition assays for α-glucosidase, α-amylase, and advanced glycation endproducts (AGEs). Results showed that finger Italian millet had the highest total phenolic content (136.4 mg FAE/100 g) and flavonoid content (115.8 mg CE/100 g). It also demonstrated superior DPPH and ABTS radical scavenging activities, along with lower IC50 values for enzyme inhibition compared to acarbose. The findings suggest that millet flavonoids could be beneficial in managing type 2 diabetes, highlighting finger Italian millet's potential as a functional food.

5. **Dr. Mrunal G. Wani et al : published january 2024)** "REVIEW ON ROLE OF MILLETS IN PREVENTION AND MANAGEMENT OF DIABETES MELLITUS"

The increasing incidence of diabetes mellitus (DM) necessitates effective prevention and management strategies, particularly through dietary modifications alongside medication. This review highlights the role of millets, an underutilized yet nutritious crop, in diabetes management. Millets are rich in fiber and antioxidants, which help lower blood glucose levels by promoting satiety and reducing insulin requirements due to their low glycemic load. The

systematic review confirms that millets can significantly aid in glycemic control and suggests their incorporation into diets for better diabetes management and prevention, emphasizing their nutritional benefits and potential health implications.

6. *Kosaraju's* book (published 4 august 2022). "New Millets: Panacea for Diabetes, Cancers, and Heart Ailments",

explores the nutritional and health benefits of millets, positioning them as a vital food source in combating modern health issue

The book emphasizes millets as ancient grains that provide essential nutrients and can b Raj e beneficial for human consumption and livestock.

Kosaraju argues that millets can play a significant role in preventing diabetes, cancer, and heart diseases due to their low glycaemic index and high fibre content.

The author discusses the decline in millet cultivation post-Green Revolution.

7. **Priya Kumari et al january 2025** :"Effects of the Yogic Practice of Surya Namaskar and the Little Millets Diet on the Management of Type-2 Diabetes Mellitus".

This study investigates the effects of Surya Namaskar and little millet on individuals with type 2 diabetes mellitus. Conducted as a randomized controlled trial at SSH Hospital in Varanasi, participants were divided into three groups: one practicing Surya Namaskar alone, another combining it with a little millet diet, and a control group receiving no intervention. Results indicated that both intervention groups experienced significant improvements in symptoms such as increased thirst, frequent urination, and fatigue. Notably, the combination of Surya Namaskar and little millet led to greater reductions in random and postprandial blood glucose levels and HbA1c compared to the other groups. The findings suggest that integrating these practices can play a crucial role in managing diabetes effectively.

8.**Dr khushboo gupta et al (2023)** "Millet the miracle of nature ."

Millets: The Miracle of Nature" is a compilation of essays aimed at raising awareness about the various benefits and uses of millets, This book emphasizes the nutritional advantages of millets, their role in sustainable agriculture, and their potential to address food security challenges

9. **Akash Kumar et al year March 2025** Exploring the Molecular Pathways Underlying the Anti-Diabetic Effects of Millets."

Diabetes mellitus (DM) is a growing global health concern, particularly in low- and middle-income countries, characterized by high blood sugar levels due to insufficient insulin production or action. The pathogenesis of DM involves multiple factors, including insulin signaling disruptions, β-cell dysfunction, and inflammation. Recent studies suggest that millets, rich in protein, fiber, and bioactive compounds, may enhance insulin sensitivity by increasing adiponectin levels and inhibiting enzymes like DPP-IV, α-amylase, and α-glucosidase. These effects could lead to improved glucose metabolism through various mechanisms, such as modulating the PI3K/AKT signaling pathway and promoting beneficial gut microbiotahis highlights the potential of dietary interventions in managing diabetes effectively.

10. **Taku W Tsusaka et al year april 2024** "Impact of regular consumption of millets on fasting and post-prandial blood glucose level: a systematic review and meta-analysis"

This study systematically reviews and analyzes the impact of millet consumption on fasting blood sugar (FBS), post-prandial blood sugar (PPBS), and glycated hemoglobin (HbA1c) levels in comparison to traditional staple diets. Using the difference-in-differences method, the analysis included ten articles for FBS and five for PPBS. Results indicated

significant reductions in FBS (11.8%) and PPBS (15.1%) levels in the millet-consuming group, with effect sizes of -0.71 and -0.42, respectively, while the control group showed no significant changes. However, the effects on HbA1c were not statistically significant, likely due to a limited number of studies. Overall, the findings support that millets can effectively manage FBS and PPBS, suggesting their potential in reducing the risk of type 2 diabetes

11. **MV jali et al year March 2012** "Efficacy of value-added foxtail millet therapeutic food in the management of diabetes and dyslipidamea in type 2 diabetic patients"

A randomized crossover study, 300 patients with type 2 diabetes mellitus were assigned to follow a millet-based diet for 90 days, designed to include moderate fiber levels as recommended by the American Diabetes Association. The study aimed to evaluate the diet's impact on glycemic control .Results showed excellent compliance, with significant reductions in HbA1c (19.14%), fasting glucose (13.5%), insulin (1.9%) among participants. However, there were no significant changes in body weight observed during the study.

12. **Bharti Ruhela et al january 2024.** "Development of Food Products by Using Millets and Medicinal Plants for Diabetes Management"

Diabetes mellitus is increasingly prevalent, particularly in India, where dietary habits contribute significantly to rising blood glucose levels. Traditional staples like wheat and rice are high in glycemic index, prompting the need for healthier alternatives. In response, five innovative food products have been developed using low-glycemic index ingredients such as barnyard millet and sorghum, supplemented with antidiabetic plant materials. These include Instant Barnyard Upma, Millets Idli Premix, Millets Mangodi, Herbal Tea Bags, and Barnyard and Sorghum crackers, all designed to replace conventional recipes while maintaining nutritional value and sensory appeal.Development of Food Products by Using Millets and Medicinal Plants for Diabetes Management.

13. **Seeta Anita et.al 2021 july** "systematic Developing Review and Meta-Analysis of the Potential of Millets for Managing and Reducing the Risk of Diabetes Mellitus."

Numerous studies highlight the effectiveness of low-carbohydrate diets in managing obesity, diabetes, and pre-diabetes. These diets can lead to significant weight loss, reduced medication needs, and even remission of type 2 diabetes when combined with appropriate therapies. The rising global incidence of diabetes, driven by factors like urbanization and obesity, emphasizes the need for dietary interventions. Millets, known for their low glycemic index, are increasingly recognized for their potential to stabilize blood sugar levels and support overall health. Incorporating millets into daily meals can enhance dietary strategies aimed at preventing and managing diabetes, showcasing the importance of nutrient-dense foods in promoting wellness. Systematic Review and Meta-Analysis of the Potential of Millets for Managing and Reducing the Risk of Developing Diabetes Mellitus.

14. **Poornima Mansoria et.al (july 2023)** "Unlocking the therapeutic potential of Millets: A path to Diabetes Control".

Diabetes mellitus is increasingly recognized as a global health crisis, significantly influenced by lifestyle factors such as diet. Recent interest has emerged in the role of millets as a dietary intervention for diabetes prevention and management. Rich in fiber, minerals, and phytochemicals, millets offer unique nutritional benefits that can enhance blood glucose control and mitigate complications associated with diabetes. This manuscript reviews existing literature on millets, focusing on their mechanisms of action, effects on glycemic control, and implications for dietary guidelines, underscoring their potential as a valuable addition to diabetes management strategies.

15.**Hemant gangurde year november 2024** "Nutrition & Health Benefits Of Millets".

Millets are vital food sources in arid and semi-arid regions, known for their drought resistance. They are rich in protein, essential amino acids, vitamins, minerals, dietary fibre, and antioxidants, making them a nutritious option. Millets contain significant amounts of sulphur-containing amino acids like methionine and cysteine, and their antioxidant properties may

enhance gut health by supporting probiotics. Additionally, millets can help prevent lifestyle-related diseases such as cardiovascular issues, diabetes, and certain cancers. Their gluten-free nature and ability to aid digestive health further emphasize their role in addressing global nutritional needs and combating malnutrition.

16.S. Nithiyanantham April 2019 ' Nutritional and functional roles of milletes"

This study systematically review of analyzed nutritional and functional role of millets .Developing tropical countries face challenges in providing sufficient plant-based proteins for both humans and animals due to factors like shrinking agricultural land, rapid urbanization, climate change, and competition between food and feed industries. Identifying and promoting underutilized millet crops, including those valued by tribal communities, offers a sustainable solution. These millets are rich in protein and other essential nutrients, and their cultivation requires fewer resources, making them a viable option to enhance food and feed security in these regions.

17. S Srivastava et . al year 2021 '**Millet**-based value-added food products for **diabetics**'

Diabetes mellitus is a metabolic disorder causing high blood sugar due to ineffective insulin secretion. With nearly half a billion people affected globally, including an alarming rise in India, addressing this issue is urgent. Millets, rich in bioactive components such as non-starch polysaccharides, flavonoids, and polyphenols, can be beneficial in diabetes management. Their inclusion in the diet can help lower the glycemic index of food, improve blood glucose control, and reduce complications in diabetics, making them a valuable addition to diabetic nutrition.

Jayalakshmi, P., & Raju, B. S. B. C Assessment of Utilization of millets and Management of Diabetes mellitus'

METHEDOLOGY:

The present study was carried out to assess the millets and their impact on diabeties management.it was conducted in total 100 students in (nutrition and dietetics) and dietician in Nagpur area.

1. STUDY DESIGN

This study will be conducted using cross sectional survey design,to Collect data using a structured questionnaire

2.STUDY AREA

The research will be conducted in Nagpur a major city in Maharashtra, in India , The target location including educational institution offering dietetics and nutrition courses, and clinical dietician.. the selection of Nagpur area provides a focused geographical scope, making data collection more manageable while still obtaining relevant insight.

3.SAMPLE SIZE

The study will include total of 100 participants. This sample size both student and practicing dietician. Both group are relevant for the study due to their academic or professional involvement in the field of nutrition.

4.SAMPLING METHOD

A convenience sampling technique will used for this study. This non probability sampling method involves selecting participants who are easily accessible and willing to participate..while it may not guarantee a completely representative sample, it is practical and efficient for exploratory or preliminary studies such as this one.

DATA COLLECTION PROCEDURE

The data collection process will involve the following step:

*The google form questionnaire will be created and reviewed for content accuracy and userfriendliness.

*The link to the form will be circulated through digital platforms such as email, whatsapp, and social media group targeting dietetics and nutrition students and professionals.

*An informed consent statement will be included at the beginning of the form, and only those who agree to participate will proceed with the questionnaire.

*The data collection period will last for 2 weeks during which reminders may be sent to encourage participation.

Responses will be automatically collected and stored securely in the associated google account.

DATA ANALYSIS

The data collected through google form will be exported to Microsoft excel for analysis. The data will be cleaned and checked for completeness. Statistical analysis will include.

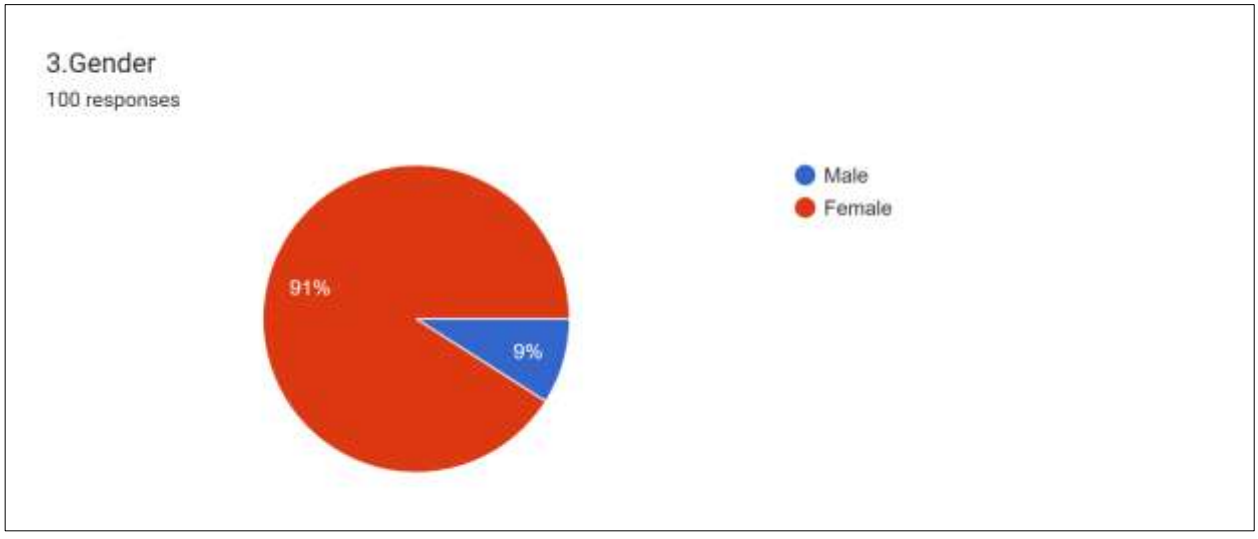
***Descriptive statistics (**frequency, percentages, means ,standard deviations) to summarize demographics in formation and response trends.

*If applicable inferential statistics may be applied to explore relationships or difference between student and professional responses.

Result

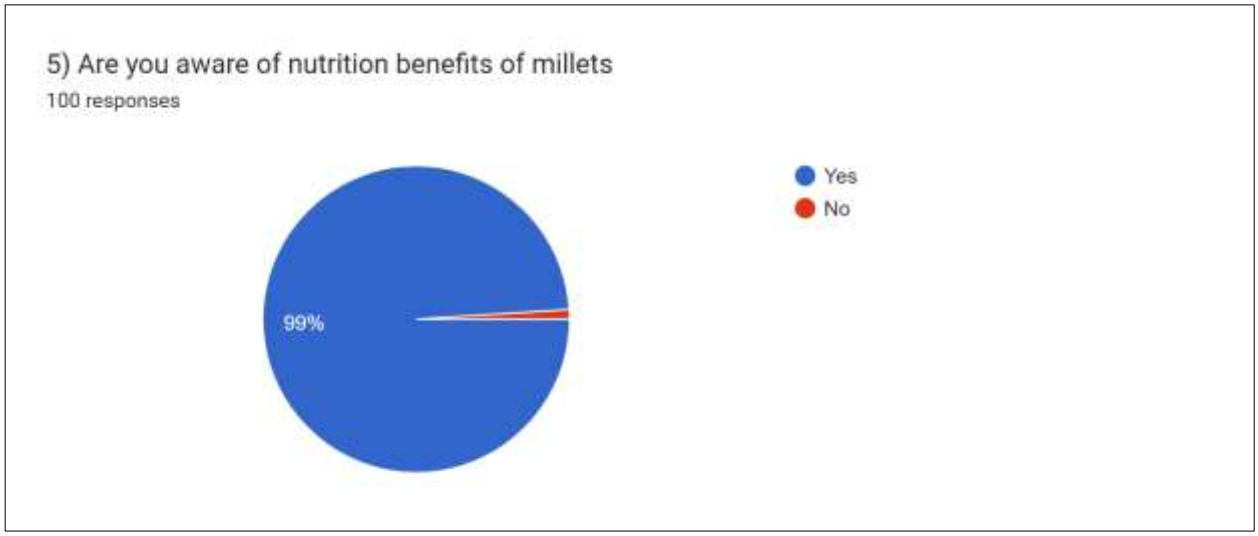
1. **Social demographic characteristic :**

- The cross sectional study was conducted among the college student in nutrition and dietetics course and dietician.to asses the awareness of different millets and their impact on diabetes management. The study included student a



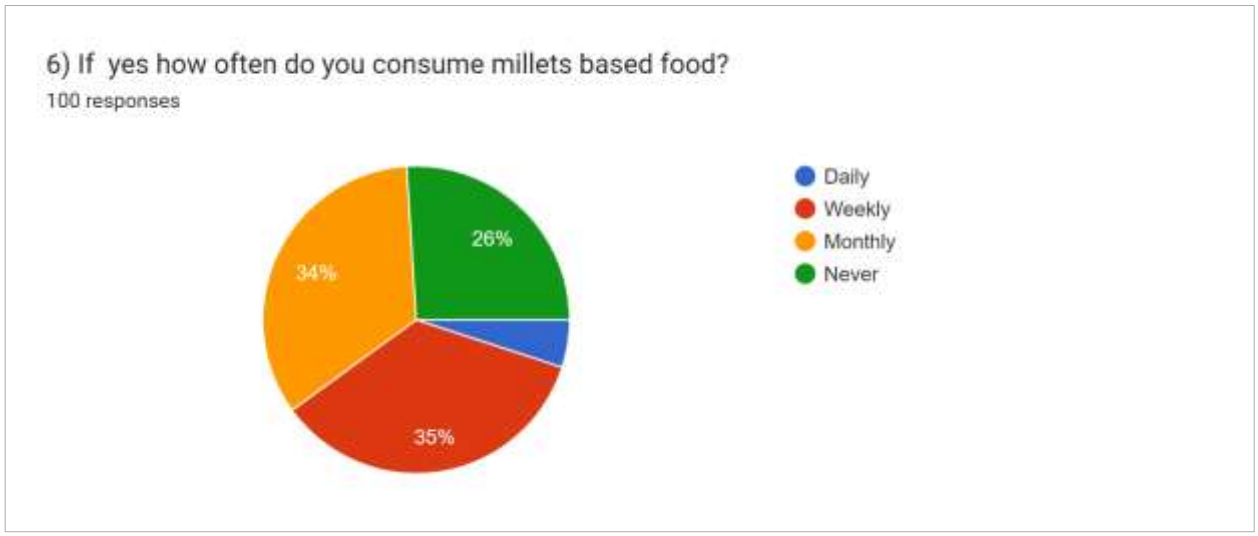
In this study regarding gender, which included both student and dietician, a large majority of participant were female (91%) and while (9%) were male. Showed a clear gender imbalance among participants. This indicates that the finding are largely influenced by female perspectives.

Awareness of the nutrition benefits of millets



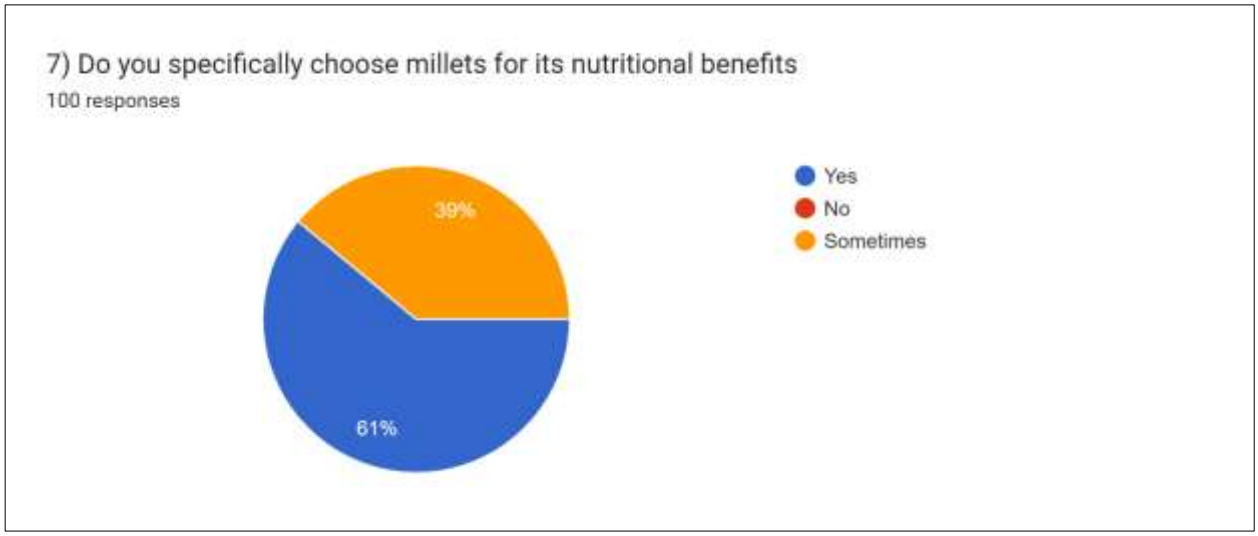
The study found that awareness of the nutritional benefits of millets is very high among participants. A total of 99 % responses being aware of these benefits, while only 1% indicated a lack of awareness. This suggested that most students and dieticians aware of nutrition benefits of millets could be due to increased health education and promotion of traditional grains.

Frequency of millets consumption



The study revealed varied patterns in the frequency of millet- based food consumption among participants. Only 5% reported consuming millets daily., while 35% consumed them on a weekly basis. Monthly consumption was reported by 34% of the participants. Interestingly, 26% stated that they never consume millets. These finding suggest that while there is moderated interest in including millets in the diet, regular daily consumption remains low. The high percentage of those weekly and monthly consume millets.

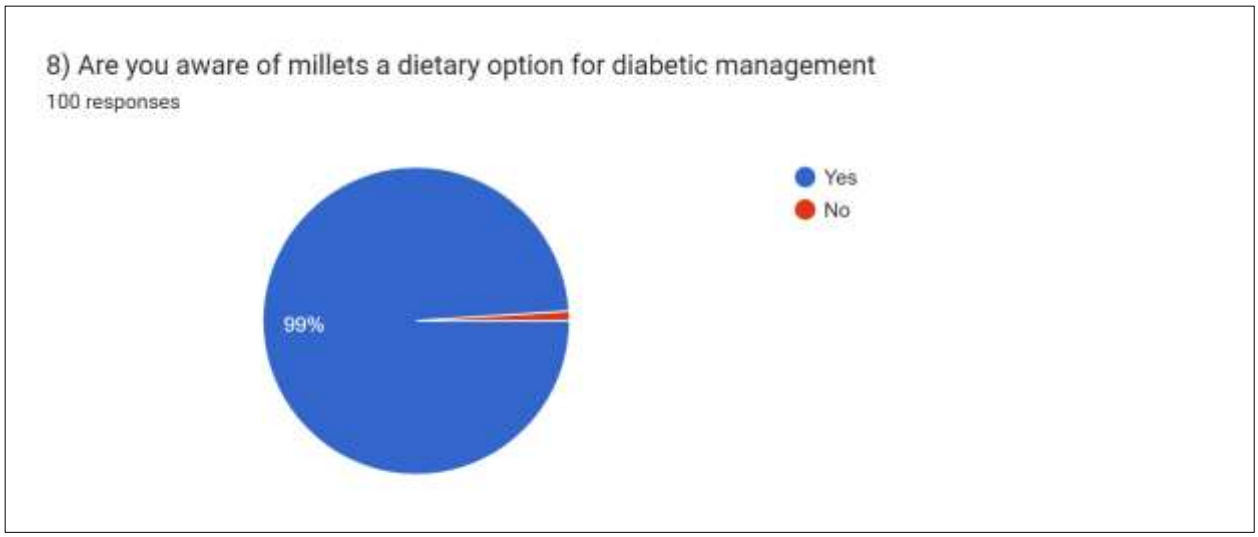
Chosen millets for nutritional benefits

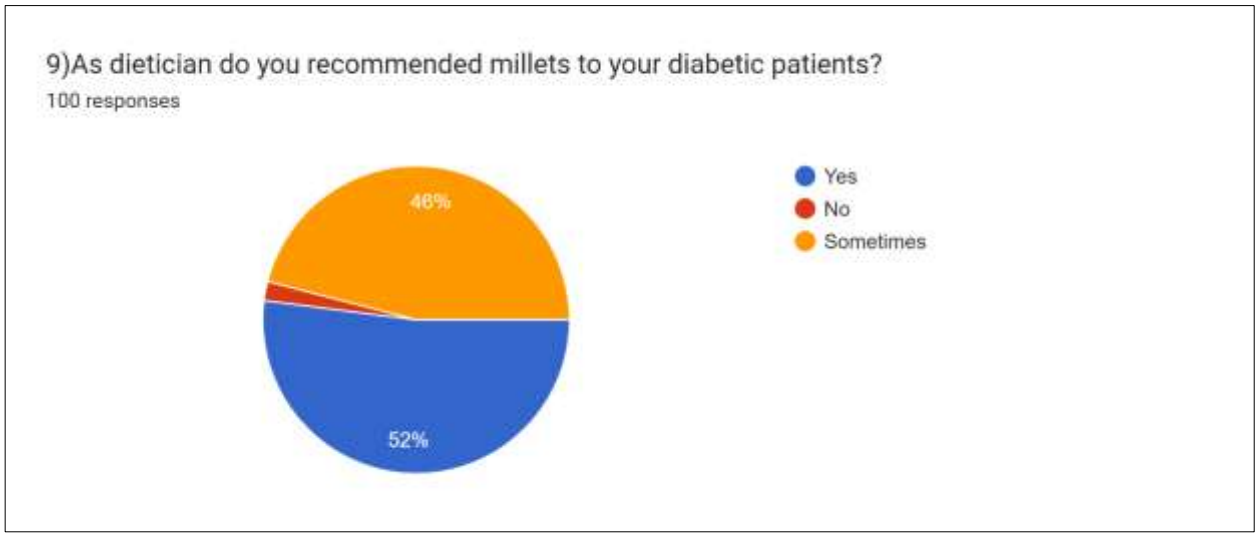


Millets are increasingly being chosen for their impressive nutritional benefits. A study shows that 61 % of people choose nutrition benefits. And 39% of people consume millets occasionally, As people become more health – conscious, millets are gaining popularity as a smart dietary choice.

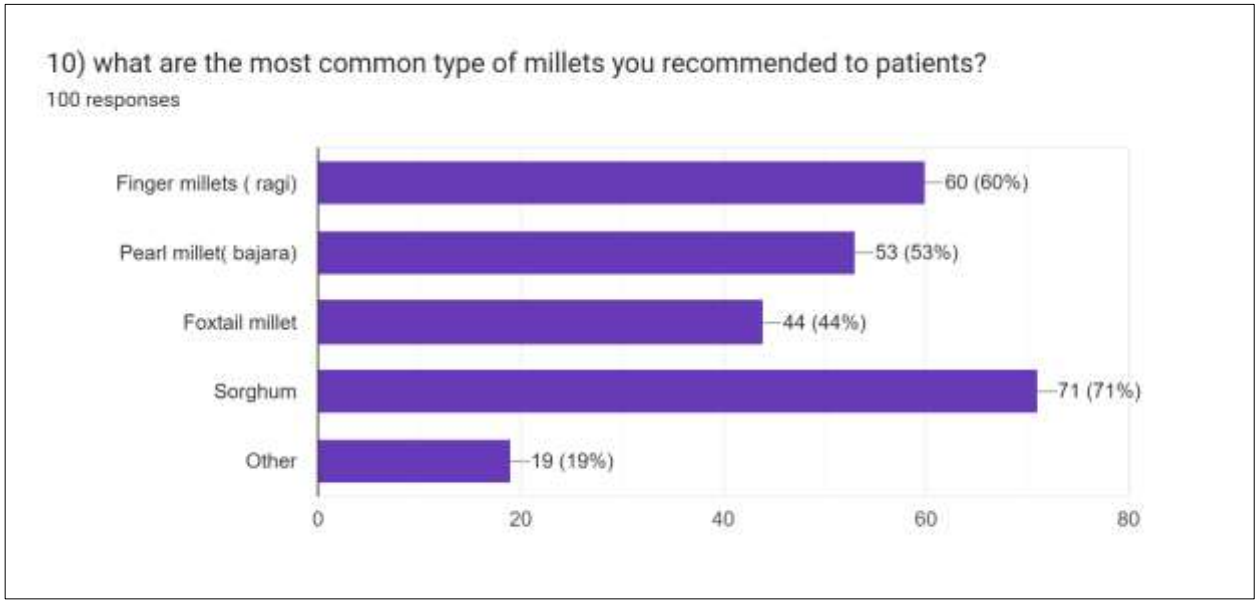
The millets dietary option for diabetic management

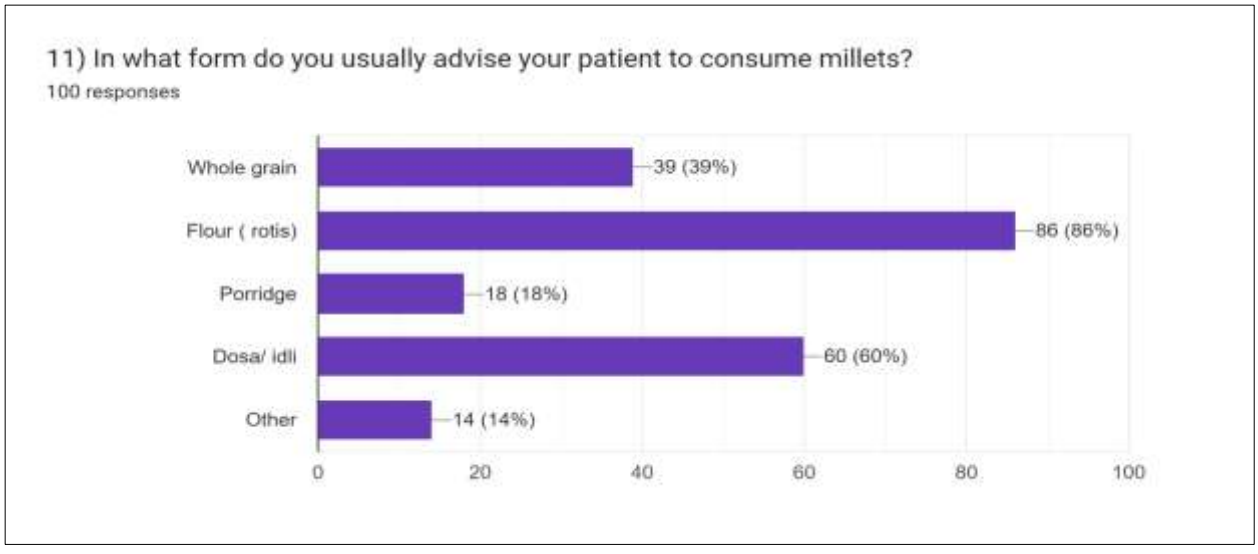
Awareness about millets as a dietary option for diabetic management is remaekably high, with 99% of the dietician and students recognizing their benefits in controlling blood sugur level. And only 1 % of the individual remain unaware of this valuable food choice. Dietician play a crucial role in promoting millets for diabetes management.





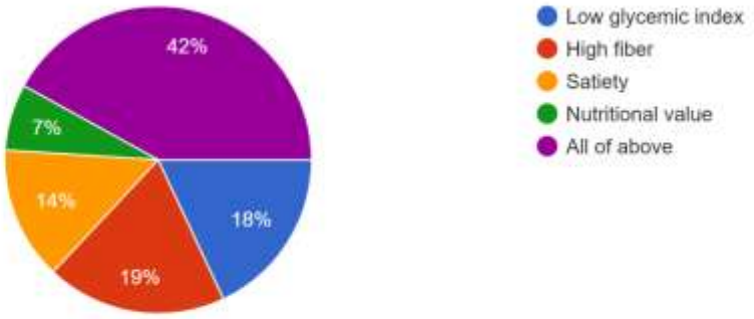
Types of millets recommended to the patients :





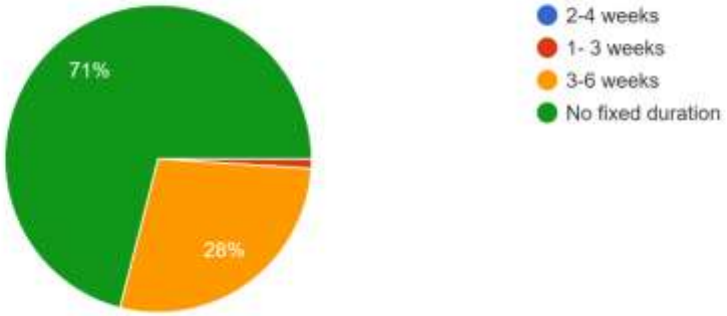
12) what is your primary reason for recommending millets ?

100 responses



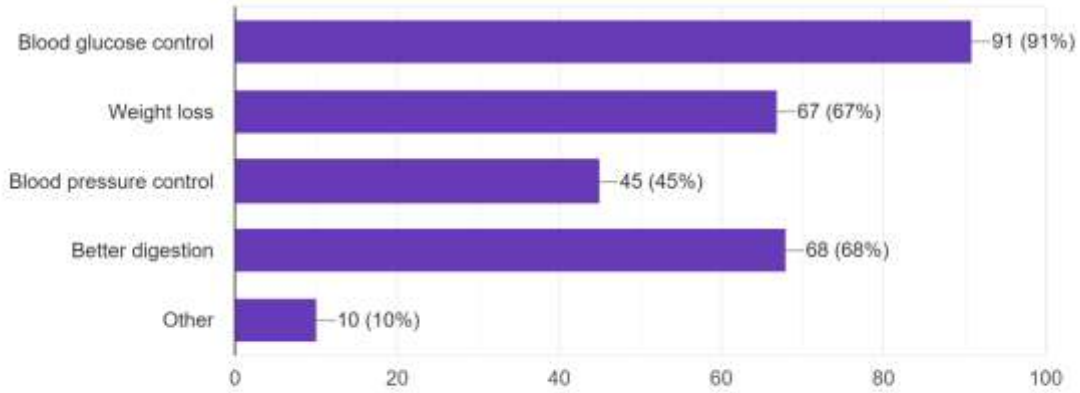
13) on average how long do you recommended patients continue millets consumption before expecting results?

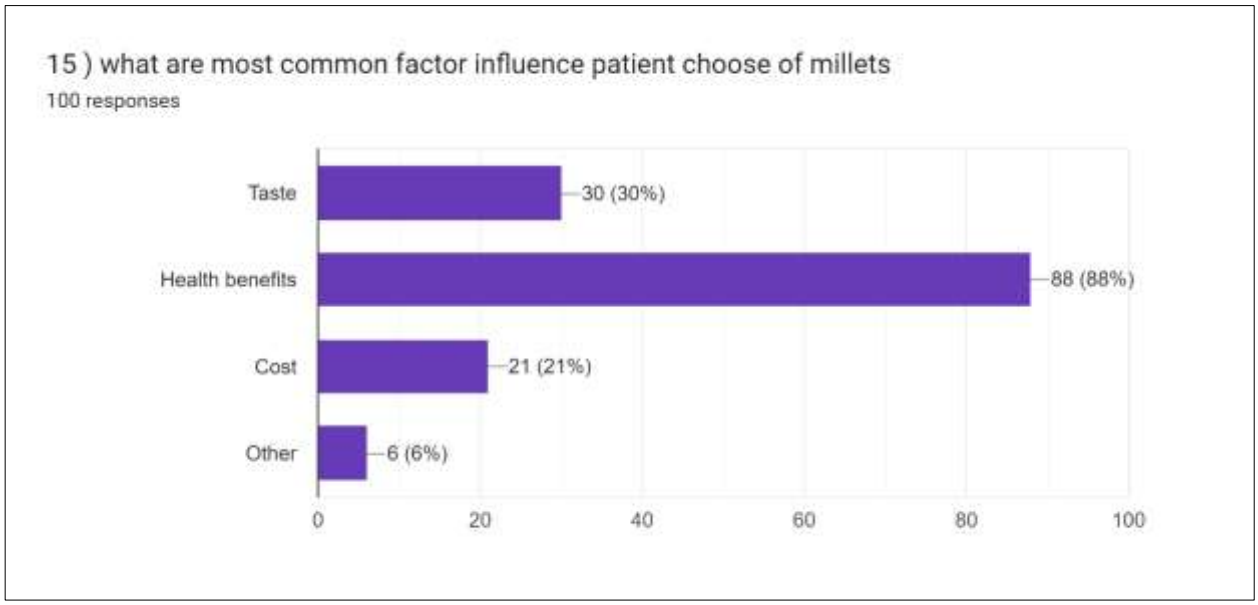
100 responses

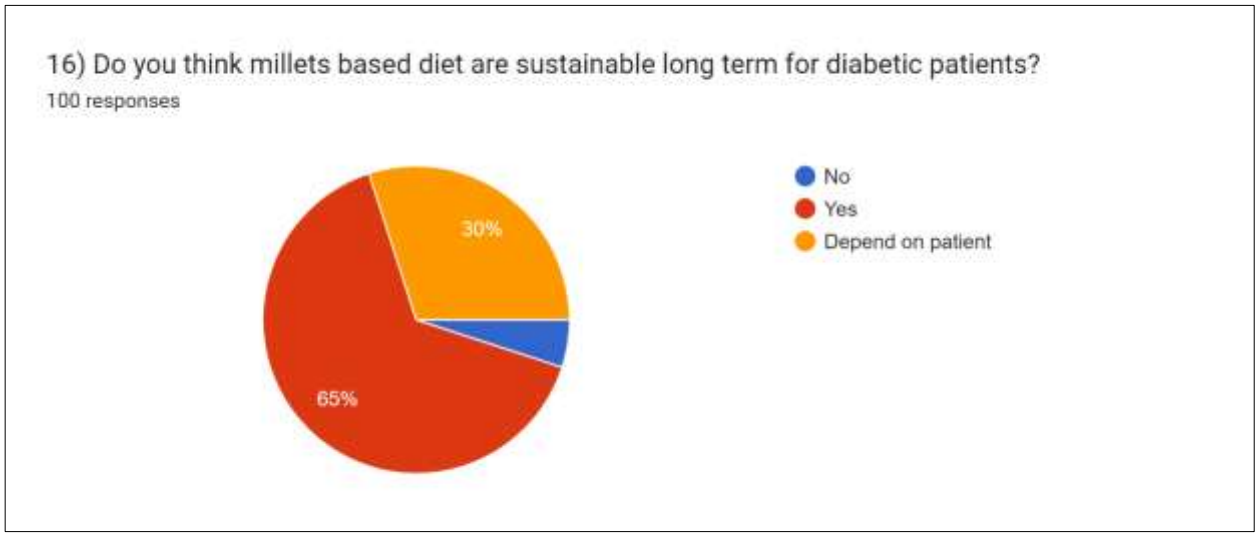


14) Hove you observed any of the following improvement in diabetic patient who consume millets?

100 responses







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